SEXUAL DIMORPHISM IN NEMERTEANS.

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It has been generally assumed by zoölogists that the sexes of the nemerteans are indistinguishable, with the exception of possible size and color differences, without an examination of the gonads. While this is generally true certain facts have been recently brought to light which show, as will be explained below, that in at least one genus the sexes are truly dimorphic. The male in this case not only bears the gonads in an entirely different part of the body than does the female, but is also distinguished by the possession of a pair of large lateral appendages which are apparently used as copulatory organs. The only other instance of an external appendage in nemerteans is the caudal cirrus in *Micrura* and related genera, but this is without relation to sex.

Many cases are known in which both size and color differences distinguish the sexes when mature. Thus it has long been known that in the common *Cerebratulus lacteus* Ver. the males in the breeding season (Coe, '95) are suffused with bright red in the anterior portions of the body and deep red in the intestinal region where the spermaries are located, while the females are much darker, duller red or brownish red, with a grayish tinge except in the anterior portions of the body. This differentiation in color is apparent some two or three months before the sexual products are ready to be discharged, in April, although in the summer and autumn months both sexes are nearly alike, with pinkish white bodies and yellowish or brownish intestinal diverticula. Many other species show somewhat similar differences in color when sexually mature, or in the breeding season of those which live for several years. It seems not improbable that the sexes in every species if carefully observed would likewise be recognizable by color modifications when their sexual products are ripe.

Little evidence is available as to the size factor in relation to

sex, but in general the exceptionally large individuals are females.

The third external sexual character, in which a real dimorphism of the sexes occurs, has been found only in a single family living in the deep sea in various parts of the world. And although both males and females of one of these forms have been known for many years the sexes have hitherto been placed in different genera. The form to which reference is made was described by Verrill nearly thirty years ago (1892) as the type of a new family, Nectonemertidæ, the males being placed in the genus *Nectonemertes*. The species was named by him *N. mirabilis*. The most remarkable feature of this new genus was the presence of a pair of lateral appendages, or tentacles, on the sides of the body just back of the head.

A. Sexual Dimorphism in Nectonemertes.

Verrill correctly noted the fact that in *N. mirabilis* the smaller and immature individuals had very short, or rudimentary, tentacles while in the largest specimen these organs attained a length much greater than the diameter of the body. The four specimens which Verrill had for study were collected by the United States Fish Commission Steamer Albatross in the North Atlantic Ocean in the region of the Sargasso Sea, between 37 and 41 degrees north latitude and between 66 and 73 degrees west longitude. The depth of water at the collecting stations varied from 600 to 1,700 fathoms. These specimens and one other from the same locality have recently been fully studied by the writer, and all prove to be males.

The worms of this species have a remarkably fish-like appearance (Figs. 1, 2), with much flattened bodies, with horizontal fins along the posterior half of the body, and a broad terminal tail fin. They are obviously adapted to a pelagic existence, and although there is no positive evidence as to the exact depth at which this particular species lives, yet several other species of the genus are known to live at intermediate depths in the deep oceans, and other forms of a somewhat similar organization have been taken in a closing net at a depth of several hundred fathoms. The epithelium covering the body in all these forms is mostly dislodged during capture, and in one or two species mentioned

below the change in pressure between their natural habitat and the surface has caused the rupture of the body walls and the extrusion of certain of the internal organs. The evidence all points to a pelagic life at great depths, that is, from several hundred feet to hundreds of fathoms. That is to say, they are truly bathypelagic organisms.

In the same collection and from the same locality were two specimens which Verrill ('92) described as belonging to another genus and species, *Hyalonemertes atlantica*, with characteristics very similar to those of *Nectomertes*, but which lacked any trace of tentacles. By a curious error, evidently made in transcribing his notes, the ovaries of these females were incorrectly described by Verrill as the gonads of *Nectonemertes*. But for this confusion it is possible that Verrill would have himself recognized the sexual dimorphism of this form.

Since Verrill's original description of *Nectonemertes* several other species of the genus have been described from as many different localities. One species, *N. pelagica* Cravens and Heath ('06), occurs off the coast of California. Another, *N. japonica* Foshay ('12), lives in Japanese waters. Three others, *N. grimaldii* Joubin ('04) from west of the Azores, *N. chavesi* Joubin ('06) from south of the Azores, *N. lobata* Joubin ('06) from near the Azores, were each described from the superficial study of a single specimen. As the specific distinctions rest largely on the peculiarities of the tentacles, Joubin's three supposed species may eventually prove to represent merely growth stages of but a single species.

The tentacles of *N. chavesi* were represented merely by blunt papillæ or short tubercles (Fig. 11, *t*) in the only specimen studied by Joubin. The photograph shows indication of minute cephalic spermaries (Fig. 11, *sp*), although Joubin did not recognize them as such. Both these characters indicate an immature male individual. In *N. grimaldii*, on the other hand, both tentacles and cephalic spermaries are well developed (Fig. 9), indicative of a mature male. Joubin correctly describes the external appearance of the spermaries, but suspected that they might be organs of a glandular or sensory nature. In the single specimen of *N. lobata* available for study by Joubin, one of the

tentacles was prolonged into a slender filament. This presumably represents merely a relaxed condition of the tentacle, for Verrill ('92) describes one or two of his specimens of *N. mirabilis* as having similar filamentous terminal portions, while in others the tentacles were contracted into relatively shorter and thicker appendages, as shown in Fig. 1.

Bürger ('09) studied and described anatomically one specimen of *Nectonemertes* from off the coast of Jumba, French Congo, which he identified as *N. mirabilis*. Finally Brinkmann ('16) has described *N. minima* from three males and one female, also collected off the west coast of Africa.

In *N. minima* the tentacles are similar to those of *N. mirabilis*, as are also those of *N. pelagica* (Fig. 19). All of these descriptions, however, were made from dead or preserved specimens. The appearance of the living animal in one of these forms, *N. mirabilis*, is shown in Fig. 18. In life the tentacles are much longer and more slender than they appear in the preserved specimen. A comparison of Figs. 18 and 19, although representing different species, will indicate the change in form which takes place upon the death of the animal.

Thus far about twenty-four specimens of the seven species enumerated above have been described as having tentacles, and all were males. Verrill, Joubin, and Bürger recognized the close structural similarity between *Nectonemertes* and *Hyalonemertes*, but Brinkmann ('12) was the first to suggest that they might represent dimorphic forms of a single species. As the name given to the male, *Nectonemertes*, has priority over that of the female, *Hyalonemertes* in Verrill's work ('92), Brinkmann correctly refers his species to the former genus.

It has been mentioned that more male individuals than females of the various species of this genus have been studied. For example, Cravens and Heath found only males in their five specimens of *N. pelagica*, while Foshay was sent six specimens of *N. japonica*, which were likewise all males. Three reasons for this suggest themselves. First, the tentacles of the male are presumably adapted for clasping and holding the female. As a result of their clinging instinct the worms hold fast to any small foreign object such as a fishing line or bait or the mesh of

a net which may be lowered to their habitat. The males are thereby drawn to the surface and collected. Second, the very conspicuous appendages of the males would direct attention to them as unusual objects and they would be carefully preserved by the inexperienced collector—and some of the specimens are known to have been obtained in this way—while the closer resemblance of the females to other common species of nemerteans would seem to give them a lesser importance. And, finally, it seems very possible from such meager descriptions as Joubin ('06) gives of six supposedly new species of *Planktonemertes* that one or more of them may actually be females of species of *Nectonemertes*, for they come from the same general region of the North Atlantic Ocean; that is, from stations west of the Azores only a few degrees apart. With these and perhaps other considerations in mind it is not surprising that more males than females of the various species are known.

Gonads.—The two sexes in *Nectonemertes* are distinguished not only by the tentacles characteristic of the males but also by the position and appearance of the gonads. The spermaries of the male (Fig. 1) are limited to the head region, while the ovaries of the female are situated in their primitive positions between the intestinal diverticula along the sides of the body (Fig. 2). The general appearance of the two sexes thereby becomes so strikingly different that their original separation into different genera is hardly surprising.

Tentacles.—Microscopic study of the tentacles of *Nectonemertes* shows that they represent slender outgrowths of the body walls; the integumentary, basement, and muscular layers being the same in both. The muscular layers, however, assume a direction at right angles to those of the body, and are of far greater thickness. The central part of the appendage is filled with an extension of the body parenchyma, with blood lacunæ of large size, and two very large nerves which originate from several branches of the lateral nerve cord at points near the base of the tentacle.

The structure of the tentacles indicates clearly that these organs are capable of a high degree of muscular contraction. The filamentous character of their terminal portions when well developed suggests that they are not simply locomotor organs,

but that they are specially adapted for grasping. The highly developed horizontal and caudal fins show that the animals are free swimming. When it is remembered further that the tentacles reach their full size only at the time of sexual maturity, the conclusion seems reasonable that they are then used for grasping the female and clinging to her during the act of insemination, as Brinkmann ('12) has suggested. Associated with these organs are spermaries with highly muscular walls (Fig. 8) opening by sperm ducts leading to the ventral surface of the head directly anterior to the tentacles (Figs. 1, 8). The number of such spermaries is limited to from twenty to thirty. The female also differs from most littoral nemerteans, but agrees with those of other bathypelagic species in having relatively few pairs of ovaries along the sides of the body (Fig. 2). And each ovary produces but one or two eggs of relatively enormous size as compared with those of most littoral species.

The reduction in the number of spermatozoa to a small fraction of the number found in a worm of a littoral species of similar size, and a corresponding reduction in the number of ova produced by the female, has evidently necessitated a conservation of the genital products by adaptations for securing the fertilization of the maximum proportion of the eggs produced.

Hence the advantage of pairing instincts and organs for accomplishing this result in place of the more primitive and wasteful processes which obtain in the littoral forms. These latter, it will be remembered, in many cases discharge an enormous number of spermatozoa and minute eggs into the water about them, with relatively small chances of any particular egg producing an embryo. In some of the smaller forms, on the other hand (as *Amphiporus*), there is a kind of pairing in which the two sexually mature individuals of opposite sex place their bodies side by side and the genital products of both are discharged together in a mass of mucus secreted by the integument of the two worms. The littoral forms moreover live in a comparatively limited environment and thus have a great advantage in this respect over these bathypelagic species, the habitat of which may extend over hundreds of miles of ocean, with a vertical range of several hundred fathoms. Hence, the advantage of

organs by which the sexes when mature may be held together until insemination occurs. For it may be assumed that fertilization of the eggs takes place within the body of the female, as in several well-known littoral and terrestrial species. The early formation of the oviducts indicates that this is probable, although we have as yet no direct evidence that it actually occurs. Moreover, it may be not unreasonable to suspect the possibility of embryonic development within the mother's body, which in the known viviparous forms is often associated with eggs of unusual size, as in *Geonemertes*, for example (Coe, '04).

The position of the sperm ducts on the ventral surface of the head just anterior to the tentacles, where they could be most effectually pressed against the open oviducts of the female, is a further indication that internal fertilization takes place. And finally, the highly muscular walls of the spermaries (Fig. 8), which are found only in bathypelagic species, doubtless serve for the forcible ejection of the spermatozoa through the slender sperm ducts which open at the summit of small extensible papillæ. The weakness of the musculature of the body walls is thus compensated for by the special musculature of the spermary. In *Bathynectes murrayi* Brinkmann finds similar muscular spermaries connected with slender sperm ducts which extend as penes far beyond the surface of the body (Figs. 15, 16, *pe*), as described below. Such a condition indicates that the sperm ducts may be actually inserted into the open oviducts of the female. Then by the contraction of the musculature of the spermary some of the spermatozoa contained in the latter would be forced into direct contact with the one or two large ova which each ovary contains. The smaller genital papillæ of *Nectonemertes* may function in a similar manner.

In littoral and terrestrial species where fertilization takes place within the body of the female the two worms, after coming in contact, secrete a great abundance of mucus which surrounds the two animals as a sheath and prevents the escape of the spermatozoa after they have been discharged by the male. These bathypelagic species, on the other hand, are but poorly supplied with mucus secreting glands and hence appear to require the actual introduction of the spermatozoa into the oviducts in order that fertilization may be assured.

B. Sexual Differentiation in Other Bathypelagic Nemerteans.

The distinction between sexual differentiation and sexual dimorphism should closely be borne in mind. As commonly used the former term has reference to those characteristics which distinguish the sexes in a form in which both sexes are easily recognized as belonging to the same species, while the latter implies morphological features so profound that the two sexes might appear to belong to different species or even larger groups. Among the nemerteans known at the present time only *Nectonemertes*, and possibly *Balænanemertes*, belong to the latter category.

It may be worth while to consider in this connection a few of the many cases of sexual differentiation which lead toward the true sexual dimorphism described above for *Nectonemertes*. In many species of nemerteans there can be no question as to sexual differentiation, for all individuals are hermaphroditic and to some extent protandric, as in the fresh-water *Stichostemma* and the terrestrial *Geonemertes* (Coe, '04). Here the young and small individuals function as males. A period of growth commonly follows the discharge of most of their spermatozoa, when they assume the characteristics of the female. In some cases both spermatozoa and ova develop at the same time. Some of these forms are viviparous, but there are also several cases of viviparity known among littoral species which are neither hermaphroditic nor protandric.

The primitive condition of the reproductive organs in the nemerteans, as is well known, is that of separate sexes, in both of which the gonads occupy similar positions along each side of the body throughout almost its entire length back of the head. The gonads are usually in pairs, alternating regularly with the intestinal lobes, or diverticula. The number of such gonads may be many thousands in a large worm, and each ovary as well as each spermary produces a large number of gametes. It is estimated that a large female Cerebratulus, which may reach a length of two meters or more, produces upwards of one hundred millions of eggs in one season. These are all discharged within the space of a few days. And in some littoral species no

larger than *Nectonemertes* the number of eggs produced is at least a hundred times greater than in the latter.

In all the bathypelagic forms the gonads of both sexes are reduced in number and size to but a small fraction of those of littoral species. A comparison of the forms hitherto described with respect to these structures will show a graded series leading to the extreme condition found in *Paradinonemertes* in which the male is provided with but two pairs of spermaries (Fig. 17 *sp*).

In all the bathypelagic forms moreover the spermaries are limited to the anterior regions of the body, and indeed in most species are far removed from their primitive position to the region of the head. In a few forms they are even limited to the area in front of the brain, where they are crowded into a dense cluster on each side of the head, with their sperm ducts opening near the lateral borders of the mouth.

In the female the ovaries remain in all species in their primitive interdiverticular positions, but as the number of intestinal diverticula becomes reduced the ovaries suffer a corresponding reduction. The extreme limit in the species known at present appears to be four or five pairs, which number occurs typically in *Pelagonemertes rollestoni*.

1. *Planktonemertes*.—In *Planktonemertes* occurs one of the first steps in the process of reduction. Strangely enough, however, of the several species of this genus thus far described only the females are known with the exception of the single specimen of *P. alberti*, in which Joubin (1906) clearly shows the two groups of spermaries behind the brain. This investigator did not, however, suspect their true nature. Fortunately an exceptionally well preserved specimen of *P. agassizii* has recently come into my hands which proves to be a sexually mature male. This was collected by the U. S. Fish Commission Steamer Albatross from near the equator in longitude 81° West; that is, off the coast of Ecuador. A study of this specimen reveals nine rounded spermaries on one side and eleven on the other, situated immediately back of the brain, medially to the lateral nerves, and laterally to the pylorus (Fig. 3, *sp*). These spermaries presumably represent the anterior interdiverticular gonads

of littoral species, although they lie far anterior to the intestine proper. Yet in this and related forms the intestinal diverticula extend far forward, even in front of the brain in many cases. It is evident that in their embryonic development these diverticula actually grow anteriorly from their primitive lateral positions, and it is quite conceivable that they carry with them the rudiments of the gonads and that only those gonads which are thus carried forward develop into spermaries. Serious objections to this hypothesis are, first, that the number of spermaries bears no relation to the number of cephalic diverticula present in the adult, and, second, even with this hypothesis a certain amount of independent migration would be necessary to give the spermaries their definite localization.

The number of intestinal diverticula in this species is commonly between thirty and fifty and the ovaries retain their primitive positions between them (Fig. 4). One of the females available for study, although of large size, had the ovaries in a very early stage of development. In this case these organs alternated regularly with the intestinal diverticula except toward the posterior end of the body. But in the specimens with mature ovaries the number was much less than that of the diverticula, ranging from about fifteen to twenty pairs (Fig. 4). Evidently some of the original ovaries have failed to develop or have been absorbed by the body tissues.

This process if carried still farther would result in a condition similar to that which Bürger ('06) found in a related species, *P. woodworthi*, in which there are only seven or eight pairs of ovaries. Bürger also found in a specimen which he erroneously identifies as *P. agassizii* "numerous" very young ovaries which alternate regularly with the diverticula in the middle portions of the body, although he does not state the precise number. Brinkmann ('16) studied a single female of *P. vanhöffeni* which had just discharged the eggs from fourteen pairs of ovaries.

The conditions in the females of all these species are thus quite in harmony with the account given above for *P. agassizii*, but only in the latter species has the male been discovered.

2. *Balænanemertes*.—Bürger ('09) describes from a single specimen a new genus which in his opinion forms a connecting link

between the nemerteans with and those without tentacular appendages. This species, *Balænanemertes chuni*, was taken in the Indian Ocean, in a region where the depth of water was 2,500 meters. This specimen, although a sexually mature male with cephalic gonads, was provided with a pair of short sickle-shaped lateral processes, or papillæ (Fig. 10, *t*) closely resembling the rudimentary tentacles in the young individuals of *Nectonemertes mirabilis*. It is by no means certain, however, that these processes might not have developed into longer tentacles if the individual had lived until the spermatozoa were quite ready to be discharged. They would doubtless have been much more conspicuous in life than they appear in the preserved specimen, for the tentacles of Nectonemertes are such highly distensible organs that they suffer enormous contraction upon preservation, as is indicated in figures 18 and 19.

There are five pairs of spermaries in this species. These are situated immediately behind the brain. Each gonad opens by a short sperm duct which leads to the summit of a blunt or rounded papilla (Fig. 10, *sp*) on the lateral border of the head. Female is still unknown.

3. *Bathynectes*.—In *Bathynectes murrayi* Brinkmann ('12) finds a remarkable modification of the reproductive organs in the male. In this bathypelagic nemertean from the North Atlantic the spermaries are provided with muscular walls as in *Nectonemertes*, and the sperm ducts, instead of ending in minute papillæ on the surface of the head as in all other species, are prolonged in some individuals into slender muscular penes (Figs. 15, 16, *pe*).

There are from five to seven pairs of these organs on the ventral side of the head, corresponding to the same number of cephalic spermaries (Figs. 15, 16). That the penis is actually an outgrowth from the body walls is shown by the fact that its walls, like those of the body, consist of basement layer and circular and longitudinal musculatures. The organ is evidently capable of muscular contraction and may be considered a true copulatory organ.

In several of the specimens collected the penes were torn from their insertions in the body walls, and Brinkmann offers the suggestion that they may have been inserted into the ovaries of the females and held there to serve as spermatophores.

The female of this species has about 25 pairs of typical interdiverticular ovaries.

4. *Paradinonemertes.*—In *Paradinonemertes drygalaskii* Brinkmann ('16), of which two specimens are thus far known, the spermaries have suffered a still further reduction in number, being limited to two pairs of gonads situated immediately behind the brain and between the stomach and the lateral nerve cords (Fig. 17, *sp*). This is the extreme limit of reduction at present known among the nemerteans. These two pairs occupy the same position in the body as do the two anterior pairs in *Planktonemertes*, and are apparently homologous with them. The female of this species is still unknown.

5. *Pelagonemertes.*—It is in the genus *Pelagonemertes* that the spermaries show the greatest deviation from the primitive arrangement. In *P. brinkmanni*, a new species collected in the northwest Pacific Ocean, there are five to seven egg-shaped spermaries in a single cluster (Figs. 5, 7, *sp.*) on each side of the head in front of the brain. These open by a group of small genital papillæ situated ventrally on the antero-lateral border of each side of the head (Fig. 7, *gp.*).

In some cases the contraction of the tissues during the capture and preservation of the worms has ruptured the delicate cephalic walls and forced the spermaries quite outside of the body. They then appear as if they were external appendages on the anterior margins of the head.

The ovaries likewise suffer great reduction in number as compared with the forms previously considered, there being usually only six pairs of these gonads (Fig. 6, *ov*). Occasionally the number may be increased to seven or eight on one or both sides. The immature ovary contains as many as four to six or more small eggs, but as development proceeds most of these are engulfed as food material for the one, two, or occasionally three very large ova which reach maturity. The total number of eggs which one of these worms produces in a season is therefore hardly more than twenty to thirty.

In *Pelagonmertes rollestoni* Bürger ('09) finds likewise five or six pairs of spermaries (Fig. 12, *sp*) closely grouped on each side in front of the brain. The sperm ducts leading from each group

open close together on the ventral surface of the head and close beside the rhynchodeal opening, somewhat as described above for *P. brinkmanni.*

In *Pelagonemertes mosleyi* there are seven or eight pairs of ovaries, while in *P. rollestoni* the number may sometimes be reduced to four or five (Fig. 13, *ov*). As each of these ovaries produces but one very large egg, or occasionally two or three, the total number of eggs which mature in a season is hardly more than ten to twenty under the most favorable conditions. This number is in marked contrast to the hundred million which a single large female of one of the littoral species discharges in the space of a few days. The few however are so abundantly provided with nourishment that it is probable that the entire embryonic development is completed without the necessity of securing additional food. Since the oviducts are formed long before the maturity of the ova, it seems reasonable to assume that fertilization is internal, and it appears quite possible that the entire embryonic history is completed within the parent's body.

Summary.—The foregoing brief survey of the structural modifications of the body, and especially of the organs concerned in reproduction, which have recently been discovered in the pelagic nemerteans shows that the series may be looked upon as representing possible steps in an evolutionary series leading from the primitive condition of the well-known littoral forms to the highly specialized adaptations of organisms living as a sparse population in the vast areas of the open oceans. These modifications all tend toward a reduction in the number of gametes produced, correlated with increasing provisions for insuring fertilization and the survival of the relatively few offspring produced, and leading eventually to a true sexual dimorphism.

BIBLIOGRAPHY.

Brinkmann, August.

'12 *Bathynectes murrayi* n. gen. n. sp. Eine neue bathypelagische Nemertine mit äusseren männlichen Genitalien. Bergens Museums Aarbok, 1912, no. 9. Pp. 1–9; pl. 1.

'16 Die pelagischen Nemertinen der deutschen Südpolarexpedition 1901–1903 (Vorlaufige Mitteilung). Bergens Museums Aarbok, 1915–16, pp. 1–9, pl. 1.

Bürger, O.

'09 Die Nemertinen. Wiss. Ergeb. d. Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia," 1898–1899, Bd. 16, pp. 171–222, 13 pls.

Coe, W. R.

'95 On the Anatomy of *Cerebratulus lacteus*. Trans. Connecticut Academy, Vol. 9, pp. 479–514, pls. 10–15.

'04 The Anatomy and Development of the Terrestrial Nemertean of Bermuda. Proc. Boston Soc. Nat. Hist., Vol. 31, pp. 531–570, pls. 23–25.

Cravens, Mary R. and Heath, Harold.

'06 The Anatomy of a Species of *Nectonemertes*. Zool. Jahrb., Bd. 23, pp. 337–356; 2 pls.

Foshay, Eleanor A.

'12 *Nectonemertes japonica;* A New Nemertean, Zool. Anz., Bd. 40, pp. 50–53.

Joubin, L.

'04 Note sur une nouvelle Némerte pélagique. Bull. Mus. Océanogr. de Monaco, no. 20.

'06 Description des Némertiens bathypélagiques capturés au cours des dernieres campagnes du Prince de Monaco (1890–1905). Bull. Mus. Océanogr de Monaco, no. 78, pp. 1–25.

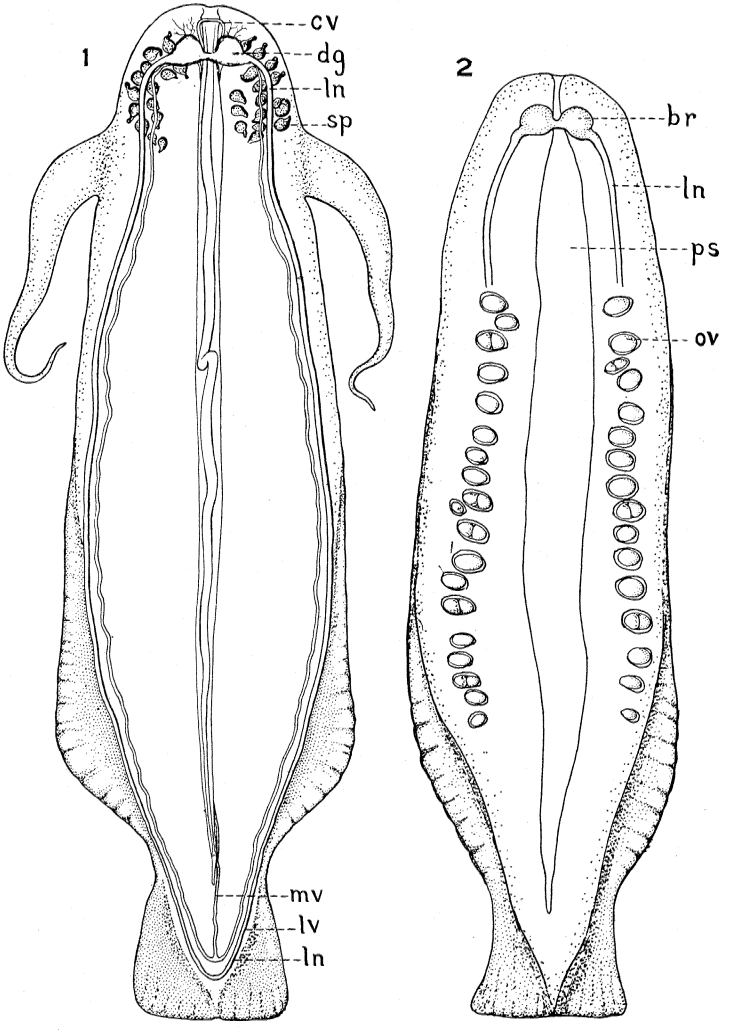
Verrill, A. E.

'92 Marine Nemerteans of New England. Trans. Connecticut Acad., Vol. 8, pp. 382–456, pls. 33–39.

Explanation of Plate I.

Fig. 1. *Nectonermertes mirabilis* Verrill. Mature male, with well-developed tentacles and upwards of fifteen pairs of spermaries (*sp*), situated on the ventro-lateral borders of the head; *dg*, dorsal ganglion of brain; *ln*, lateral nerve; *cv*, cephalic blood vessel; *mv*, median blood vessel; *lv*, lateral blood vessel. × 6.

Fig. 2. Female of same species, with from sixteen to nineteen ovaries (*ov*) on each side of body. Each ovary contains but one large ovum, or sometimes two; *br*, brain; *ps*, proboscis sheath. × 6.



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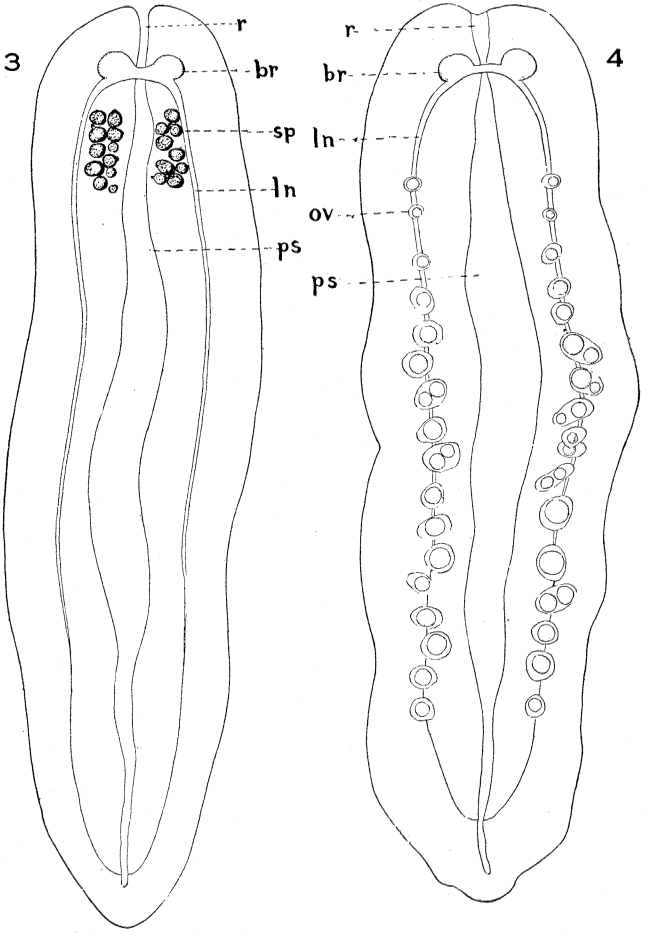
EXPLANATION OF PLATE II.

FIG. 3. *Planktonemertes agassizii* Woodworth. Outline of body of mature male with nine spermaries (*sp*) opening on the ventral surface on one side of the body immediately back of the brain and eleven on the other side; *r*, rhynchodeum; *br*, brain; *ln*, lateral nerve; *ps*, proboscis sheath. × 6.

FIG. 4. Outline of body of female of same species, showing the ovaries (*ov*), each with one or occasionally two large ova, situated beneath the lateral nerves on each side of the body. × 6.



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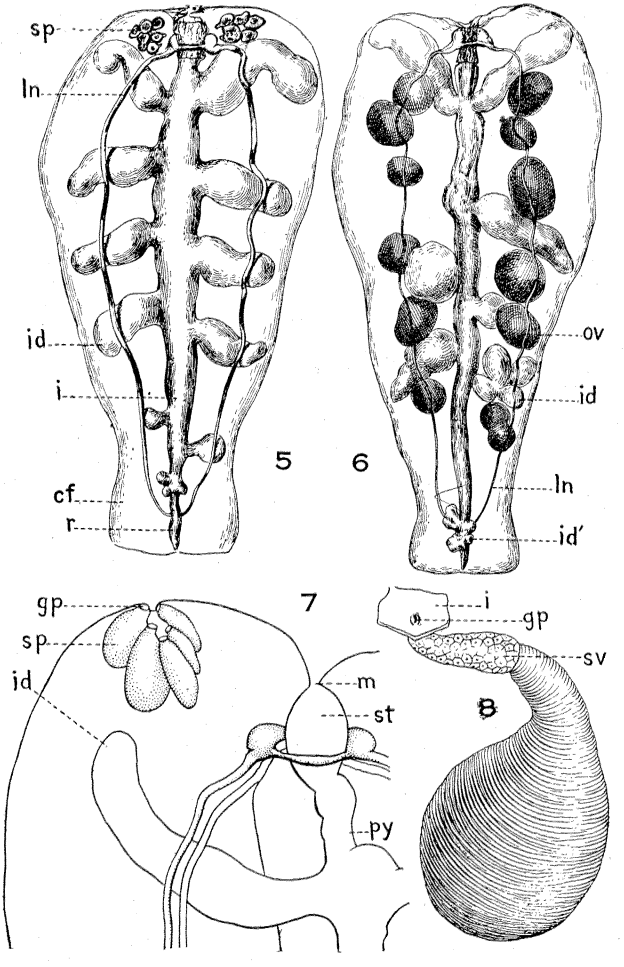
EXPLANATION OF PLATE III.

FIG. 5. *Pelagonermertes brinkmanni*, new species. Outline of body of male, showing the spermaries (*sp*) situated on the anterior margin of the head. The digestive and nervous systems are also shown; *i*, intestine; *id*, intestinal diverticulum; *r*, rectum; *ln*, lateral nerve; *cf*, caudal fin. × 6.

FIG. 6. Outline of body of female of same species, showing the six pairs of ovaries (*ov*), each with usually a single large egg. × 6.

FIG. 7. Anterior portion of body of same species, showing the five ovate spermaries (*sp*) which open on the anterior border of the side of the head; the genital openings here lie close together on blunt papillæ, but in some cases are more widely separated, due to different contraction of the adjacent tissues; *m*, mouth; *st*, stomach; *id*, intestinal diverticulum; *py*, pylorus. × 12.

FIG. 8. *Nectonemertes mirabilis*. A mature spermary, showing its thick muscular layer; *sv*, thin-walled seminal vesicle; *gp*, genital papilla. × 60.



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EXPLANATION OF PLATE IV.

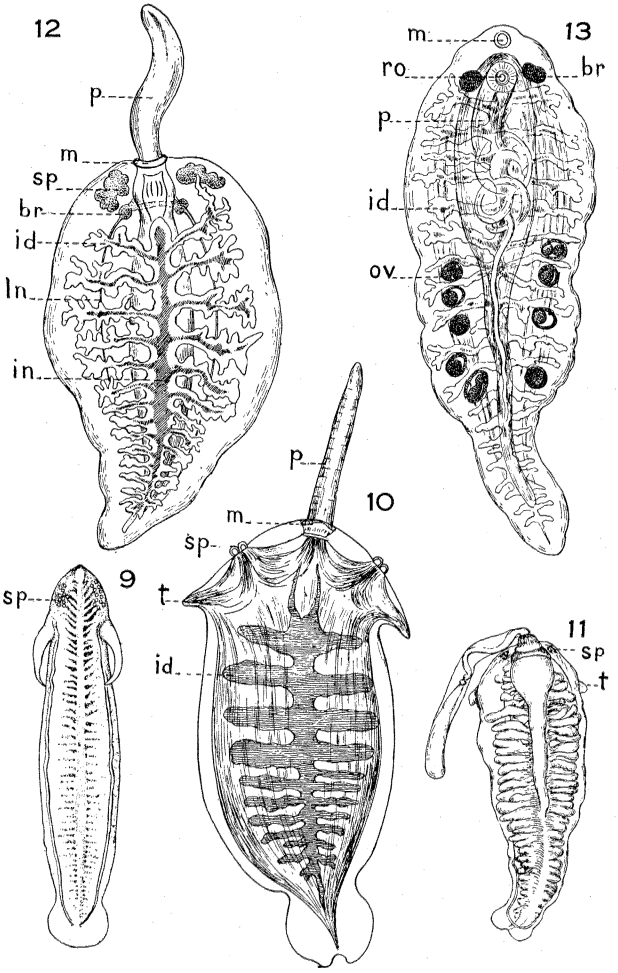
FIG. 9. *Nectonemertes grimaldii* Joubin. Male. Sketch of living animal, showing tentacles of medium size. × 1½. (After Joubin, '06.)

FIG. 10. *Balænanemertes chuni* Bürger. Sketch of male after preservation, showing the rudimentary tentacles (*t*) and the genital papillæ (*sp*) on which the sperm ducts open. × 8. (After Bürger, '09).

FIG. 11. *Nectonemertes chavesi* Joubin. From photograph of male with rudimentary tentacles (*t*). The spermaries (*sp*) are indicated on each side of the head. × 5. (After Joubin '06.)

FIG. 12. *Pelagonemertes rollestoni* Moseley. Adult male, with a single group of five or six closely placed spermaries (*sp*) on each side of the head; *p*, partially extruded proboscis; *m*, mouth; *br*, brain; *in*, intestine; *id*, intestinal diverticulum; *ln*, lateral nerve. × 3. (After Bürger, '09.)

FIG. 13. *P. rollestoni*. Female, showing the four or five ovaries (*ov*) on each side, each with from one to three ova; *ro*, rhynchodeal opening; other lettering as in figure 12. × 8. (After Bürger, '09.)



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EXPLANATION OF PLATE V.

FIG. 14. *Nectonemertes minima.* Outline of head, showing position of the spermaries (*sp*) with their long genital ducts (*sd*) leading to the ventro-lateral surfaces of head; *m*, mouth; *br*, brain; *t*, base of tentacle. × 24. (After Brinkmann, '16.)

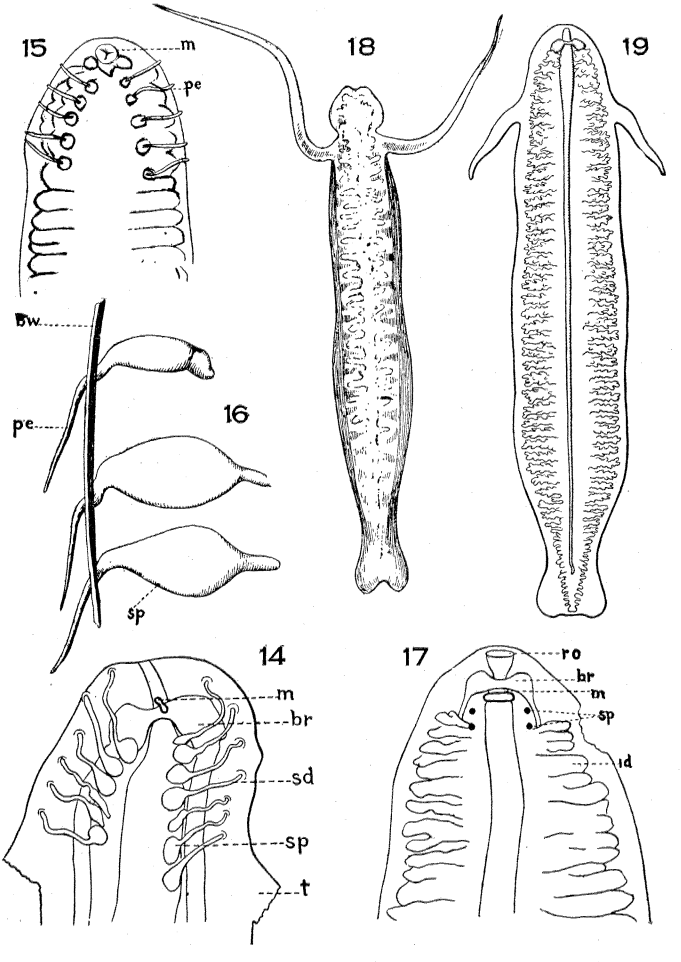
FIG. 15. *Bathynectes murrayi.* Outline of anterior portion of body, showing the five pairs of protruding genital ducts (penes, *pe*); *m*, mouth. × 6. (After Brinkmann, '12.)

FIG. 16. Same species. Outline of three of the muscular walled spermaries (*sp*), showing the genital ducts (*pe*) protruding from the body walls (*bw*). × 12. (After Brinkmann, '12.)

FIG. 17. *Paradinonemertes drygalskii.* Outline of anterior portion of body of male, showing the two pairs of spermaries (*sp*) behind the brain (*br*); *ro*, rhynchodeum; *m*, mouth; *id*, intestinal diverticulum. × 12. (After Brinkmann, '16.)

FIG. 18. *Nectonemertes mirabilis.* Sketch of living, sexually mature male with fully developed tentacles. Length of body after preservation 19 mm. × 4. (After Bürger, '09.)

FIG. 19. *N. pelagica.* Outline of body of sexually mature male. × 6. (After Cravens and Heath, '06.)



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